

XX.—*On the Homologies of the Shoulder-girdle of the Dipnoans and other Fishes.* By THEODORE GILL, M.D., Ph.D., &c.*

FEW problems involving the homologies of bones in the vertebrate branch have been in so unsatisfactory a condition as that respecting the shoulder-girdle and its constituents in fishes. But the recent observations of Bruhl, Gegenbaur, and Parker have thrown a flood of light upon the subject. Some minor questions, however, appear still to be unsettled; the writer, at least, has not been able to convince himself of the correctness of all the identifications, and of the names conferred as expressions thereof. Recent study has increased such doubts respecting the applicability of former nomenclatures, and has led to conclusions different from those announced by previous investigators.

The following are assumed as premises that will be granted by all zootomists:—

1. Homologies of parts are best determinable, *cæteris paribus*†, in the most nearly related forms.

2. Identifications should proceed from a central or determinate point outwards.

The applications of these principles are embodied in the following conclusions:—

1. The forms that are best comparable and that are most nearly related to each other are the Dipnoi, an order of fishes at present represented by *Lepidosiren*, *Protopterus*, and *Ceratodus*, and the Batrachians as represented by the Ganocephala, Salamanders, and Salamander-like animals.

2. The articulation of the anterior member with the shoulder-girdle forms the most obvious and determinable point for comparison in the representatives of the respective classes.

The Girdle in Dipnoans.

- I. The proximal element of the anterior limb in the Dipnoi has, almost by common consent, been regarded as homologous with the *humerus* of the higher vertebrates.

- II. The humerus in the Urodele Batrachians, as well as the extinct Ganocephala and Labyrinthodontia, is articulated chiefly with the coracoid.

Therefore the element of the shoulder-girdle with which the humerus of the Dipnoi is articulated must also be regarded

* Abstract, communicated by the Author, from a forthcoming work ('Arrangement of the Families of Fishes') now being printed for the Smithsonian Institution.

† Parts affected by teleological modifications may be excepted.

as the *coracoid* (subject to the proviso hereinafter stated), unless some specific evidence can be shown to the contrary. No such evidence has been produced.

III. The scapula in the Urodele and other Batrachians is entirely or almost wholly excluded from the glenoid foramen, and above the coracoid.

Therefore the corresponding element in Dipnoi must be the *scapula*.

IV. The other elements must be determined by their relation to the preceding, or to those parts from or in connexion with which they originate.

All those elements in *immediate* connexion* with the pectoral fin and the scapula must be homologous as a whole with the coraco-scapular plate of the Batrachians; that is, it is infinitely more probable that they represent as a whole or as dismemberments therefrom the coraco-scapular element than that they have independently originated.

But the homogeneity of that coraco-scapular element forbids the identification of the several elements of the fish's shoulder-girdle with regions of the Batrachian's coraco-scapular plate.

And it is equally impossible to identify the fish's elements with those of the higher reptiles or other vertebrates which have developed from the Batrachians. The elements in the shoulder-girdles of the distantly separated classes *may* be (to use the terms introduced by Mr. Lankester) homoplastic; but they *are not* homogenetic.

Therefore they must be named accordingly.

The element of the Dipnoan's shoulder-girdle continuous downwards from the scapula, and to which the coracoid is closely applied, may be named *ectocoracoid*.

V. Neither the scapula in Batrachians nor the cartilaginous extension thereof, designated suprascapula, is dis severed from the coracoid.

Therefore there is an *à priori* improbability against the homology with the scapula of any part having a distant or merely ligamentous connexion with the humerus-bearing element.

Consequently, as an element better representing the scapula exists, the element named scapula (by Owen, Günther, &c.) cannot be the homologue of the scapula of Batrachians.

On the other hand, its more intimate relations with the skull and the mode of development indicate that it is rather an element originating and developed in more intimate connexion with the skull.

* The so-called scapula and suprascapula of most authors are excluded from this connexion.

We may therefore regard it, with Parker, as a *post-temporal*.

VI. The shoulder-girdle in the Dipnoi is connected by an azygous differentiated cartilage, swollen backwards.

It is more probable that this is the homologue of the *sternum* of Batrachians, and that in the latter that element has been still more differentiated and specialized, than that it should have originated *de novo* from an independently developed nucleus.

The homologies of the elements of the shoulder-girdle of the Dipnoi appear then to be as follows :—

Nomenclature adopted.	Owen.	Parker.	Günther.
HUMERUS.	Humerus.	Humerus.	Forearm.
CORACOID (OR PARAGLENAL)*.	Coracoid.	Scapula.	Humeral cartilage.
SCAPULA.		Supraclavicle.	Coracoid‡.
ECTOCORACOID (OR CORACOID)†.		Clavicle.	
STERNUM‡.		Epicoracoid.	Median cartilage.
POSTTEMPORAL.	Scapula.	Posttemporal.	Suprascapula.

The Girdle in other Fishes.

Proceeding from the basis now obtained, a comparative examination of other types of fishes successively removed by their affinities from the Lepidosirenids may be instituted.

I. With the humerus of the Dipnoans the element in the Polypterids (single at the base but immediately divaricating, and with its limbs bordering an intervening cartilage) which supports the pectoral and its basilar ossicles must be homologous.

But it is evident that the external elements of the so-called carpus of teleosteoid Ganoids are homologous with that element in Polypterids.

* Gelenkstelle der Brustflosse am primären Schulterknorpel (Gegenbaur).

† Clavicula (Gegenbaur).

‡ Verbindungsstelle des beiderseitigen Schulterknorpels (Gegenbaur).

Prof. Gegenbaur regards the median cartilage as a dismemberment of a common cartilage, the upper division of which receives the pectoral limb, while the lower unites with the corresponding dismemberment of the opposite side and forms the median cartilage.

§ The suture separating the "coracoid" into two portions has been observed by Dr. Günther, but he could "not attach much importance to this division."

Therefore those elements cannot be carpal, but must represent the humerus.

II. The element with which the homologue of the humerus, in Polypterids, is articulated must be homologous with the analogous element in Dipnoans, and therefore with the *coracoid*.

The coracoid of Polypterids is also evidently homologous with the corresponding element in the other Ganoids; and consequently the latter must be also *coracoid*.

It is equally evident, after a detailed comparison, that the single coracoid element of the Ganoids represents the three elements developed in the generalized Teleosts (Cyprinids &c.) in connexion with the basis of the pectoral fin; and such being the case, the nomenclature should correspond. Therefore the upper element may be named *hypercoracoid*, the lower *hypocoracoid*, and the transverse or median *mesocoracoid*.

III., IV. (*Proscapula*, or united *scapula* and *ectocoracoid*.) The two elements of the arch named by Parker, in *Lepidosiren*, "supraclavicle" (= scapula) and "clavicle" (= ectocoracoid) seem to be comparable together and as a whole with the single element carrying the humerus and pectoral fin in the Crossopterygians (*Polypterus* and *Calamoichthys*) and other fishes*, and therefore not identical respectively with the "supraclavicle" and "clavicle" (except in part) recognized by him in other fishes.

As this compound bone, composed of the scapula and ectocoracoid fused together, has received no name which is not ambiguous or deceptive in its homological allusions, it may be designated the *proscapula*.

V. The posttemporal of the Dipnoans is evidently represented by the analogous element in the Ganoids generally, as well as in the typical fishes.

The succeeding elements (outside those already alluded to) appear from their relations to be developed from or in connexion with the posttemporal, and not from the true scapular apparatus; they may therefore be named *posttemporal*, *posterotemporal*, and *teleotemporals*.

The homologies of the elements of the girdle of Dipnoans with those of other fishes, and the added elements in the latter, will be as follows:—

* Dr. Günther (Phil. Trans. vol. clxi. p. 531) has observed, respecting the division in question in *Lepidosiren* and *Ceratodus*:—"I cannot attach much value to this division; the upper piece is certainly not homologous with the scapula of Teleostean fishes, which is far removed from the region of the pectoral condyle."

	Cuvier.	Owen.	Gegenbauer.	Parker.
ACTINOSTS.	Os du carpe.	Carpal.	Basalstücke der Brustflosse.	Brachial.
CORACOID OR PARAGLENAL.	{ Simple in Dipnoi and Ganoidei.			
HYPERCORACOID.	Radial.	Ulna.	Oberes Stück (Scapulare).	Scapula.
MESOCORACOID.	Troisième os de l'avant-bras qui porte la nageoire pectorale.	Humerus.	Spangenstück.	Precoracoid.
HYPOCORACOID.	Cubital.	Radius.	Vorderes Stück (Procoracoid).	Coracoid.
PROSCAPULA*.	Humeral.	Coracoid.	Clavicula.	Clavicle.
SCAPULA. ECTOCORACOID.	{ Differentiated only in Dipnoi.			
STERNUM.	Differentiated in Dipnoi.			
POSTTEMPORAL ELEMENTS.				
POSTTEMPORAL.	Suprascapulaire.	Suprascapula.	Supraclaviculare (a).	Posttemporal.
POSTEROTEMPORAL.	Scapulaire.	Scapula.	Supraclaviculare (b).	Supraclavicle.
TELEOTEMPORALS.	Os coracoïdien.	Clavicle.	Accessorisches Stück.	Postclavicles.

It will thus be seen that the determinations here adopted depend mainly (1) on the interpretation of the homologies of the elements with which the pectoral limbs are articulated, and (2) on the application of the term "coracoid." The name "coracoid," originally applied to the process so called in the human scapula, and subsequently extended to the independent element homologous with it in birds and other vertebrates, has been more especially retained (*e.g.* by Parker in mammals &c.) for the region including the glenoid cavity. On the assumption that this may be preferred by most zootomists, the preceding terms have been applied. But if the name should be restricted to the proximal element nearest the glenoid

* The name scapula might have been retained for this element, as it is (if the views here maintained are correct) homologous with the entire scapula of man, less the coracoid and glenoid elements; but the restricted meaning has been so universally adopted, that it would be inexpedient now to extend the word.

cavity in which ossification commences, the name *paraglenal* (given by Dugès to the cartilaginous glenoid region) can be adopted; and the coracoid would then be represented (in part) rather by the element so named by Owen. That eminent anatomist, however, reached his conclusion (only in part the same as that here adopted) by an entirely different course of reasoning, and by a process, as it may be called, of elimination; that is, recognizing first the so-called "radius" and "ulna," the "humerus," the "scapula," and the "coracoid" were successively identified from their relations to the elements thus determined, and because they were numerically similar to the homonymous parts in higher vertebrates.

The detailed arguments for these conclusions, and references to the views of other authors, will be given in a future memoir. I will only add here that these homologies seem to be fully sustained by the relations of the parts in the generalized Ganocephalous Batrachians (*Apateon* or *Archegosaurus*, &c.).

XXI.—*Additions to the Australian Curculionidæ.* Part IV.

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BRACHYDERINÆ.

Evas lineatus.

MOLYTINÆ.

Psaldus ammodytes.

HYPERINÆ.

Hypera acaciæ.

Prophæsia confusa.

HYLOBIINÆ.

Orthorhinus tenellus.

— *infidus.*

— *carinatus.*

ERIRHININÆ.

Agestra, n. g.

— *suturalis.*

Eniopea, n. g.

— *amœna.*

Diethusa, n. g.

— *fervida.*

Emplesis filirostris.

— *storeoides.*

Lybæba, n. g.

— *subfasciata.*

— *repanda.*

Enide, n. g.

— *porphyrea.*

— *æstuanus.*

— *saniosa.*

Hedyopsis, n. g.

— *selligera.*

Gerynassa, n. g.

— *nodulosa.*

— *basalis.*

Dicomada, n. g.

— *litigiosa.*

— *ovalis.*

— *terrea.*

Paryzeta, n. g.

— *musiva.*

Xeda, n. g.

— *amplipennis.*

— *bilineata.*

Olanæa, n. g.

— *nigricollis.*

Antyllis, n. g.

— *setosa.*

— *griseola.*

— *aurulenta.*

Cyttalia, n. g.

— *griseipila.*

Phrenozemia lunata.

Meriphus coronatus.